TCO_model_xlwings

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1 Model the Total Cost of Ownership for electric transport vehicles

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1.0.1 Import libraries

Import libraries:

[42]:
```
<IPython.core.display.HTML object>
```

1.0.2 Run Excell spreadsheet Topsector Logistiek

To be able to calculate the TCO value for several input values, we rewrite values in the excel sheet and then import the results in this notebook.

Ask the user for input values and insert in excel sheet.

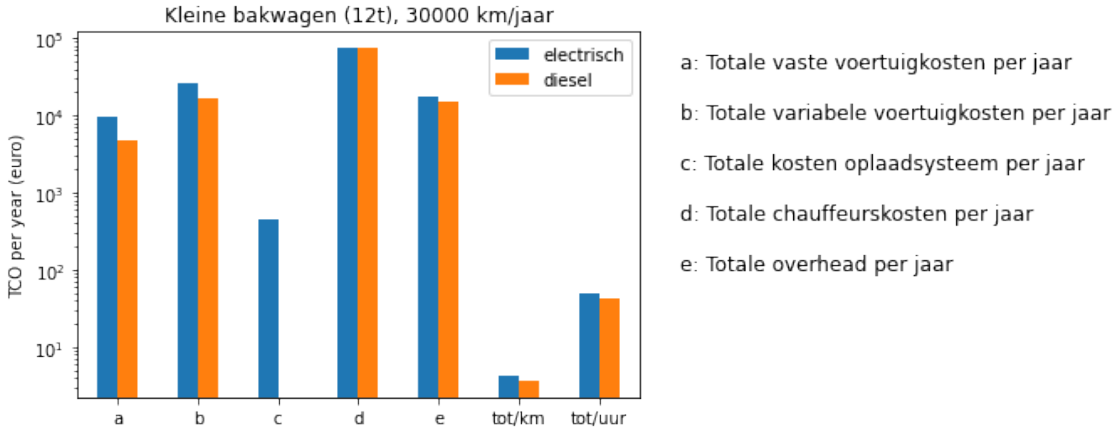
```
Voertuigtype: Kleine bakwagen (12t)
Koelmachine (J/N): j
Verwacht jaarkilometrage: 30000
Grijze/groene elektriciteit: grijs
Capaciteit vrachtwagenbatterij:
Vermogen eigen oplaadsysteem:
```

Read results from workbook and put in a list, then show in a table.

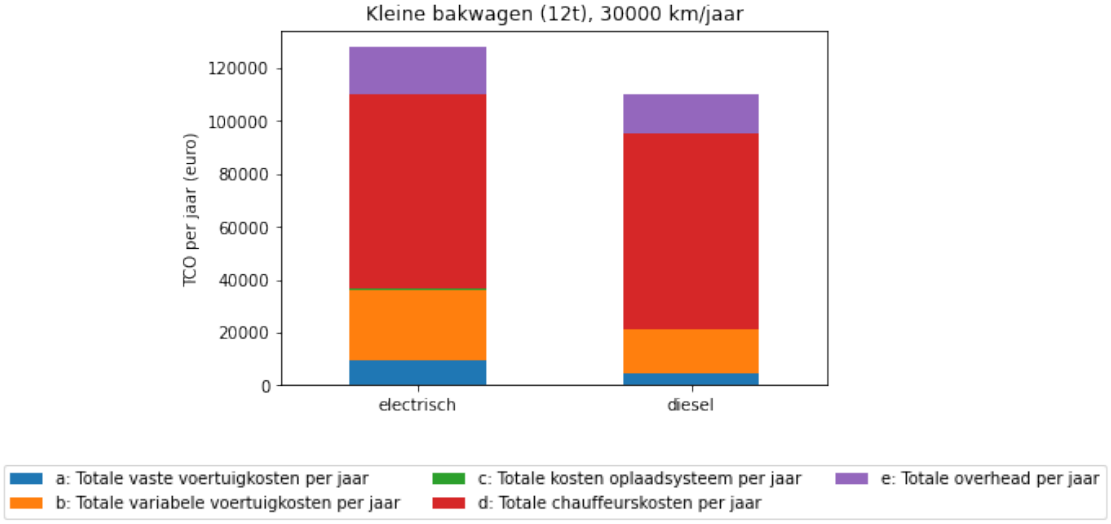
[5]:

	EV	Diesel
a: Totale vaste voertuigkosten per jaar	9708.6589	4669.8770
b: Totale variabele voertuigkosten per jaar	26209.1183	16486.4099
c: Totale kosten oplaadsysteem per jaar	447.0000	0.0000
d: Totale chauffeurskosten per jaar	73944.0000	73944.0000
e: Totale overhead per jaar	17649.4044	15216.0459
Totale kosten per km: (a+b+c+d+e)/ kms per jaar	4.2653	3.6772
Totale kosten per uur: (a+b+c+d+e)/ uren per jaar	49.2147	42.4294

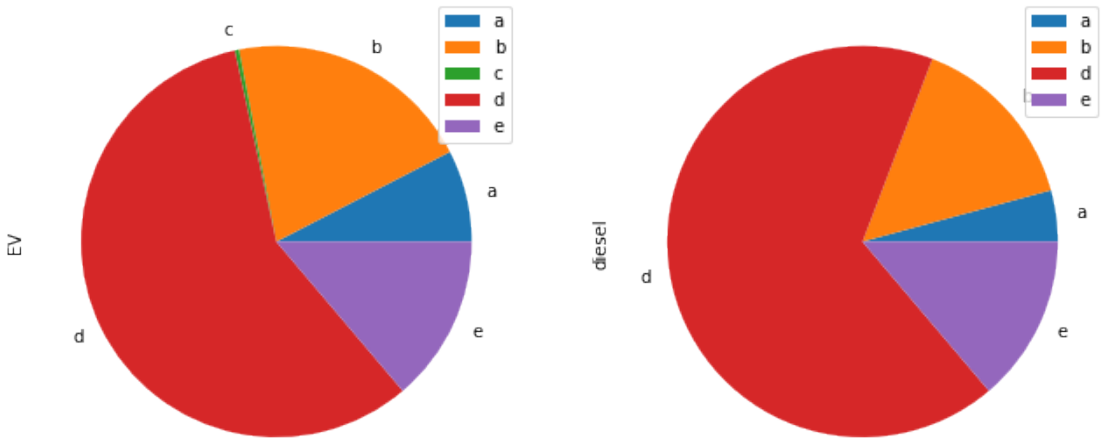
Plot the tco components for EV and diesel.



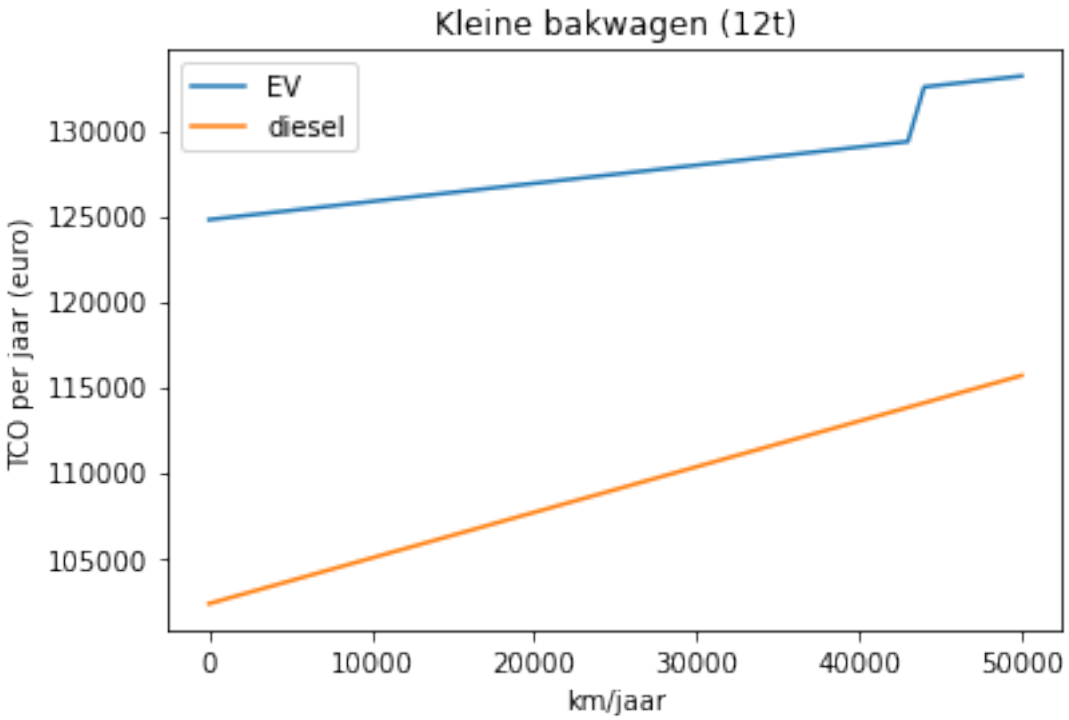
Plot as a stacked diagram.



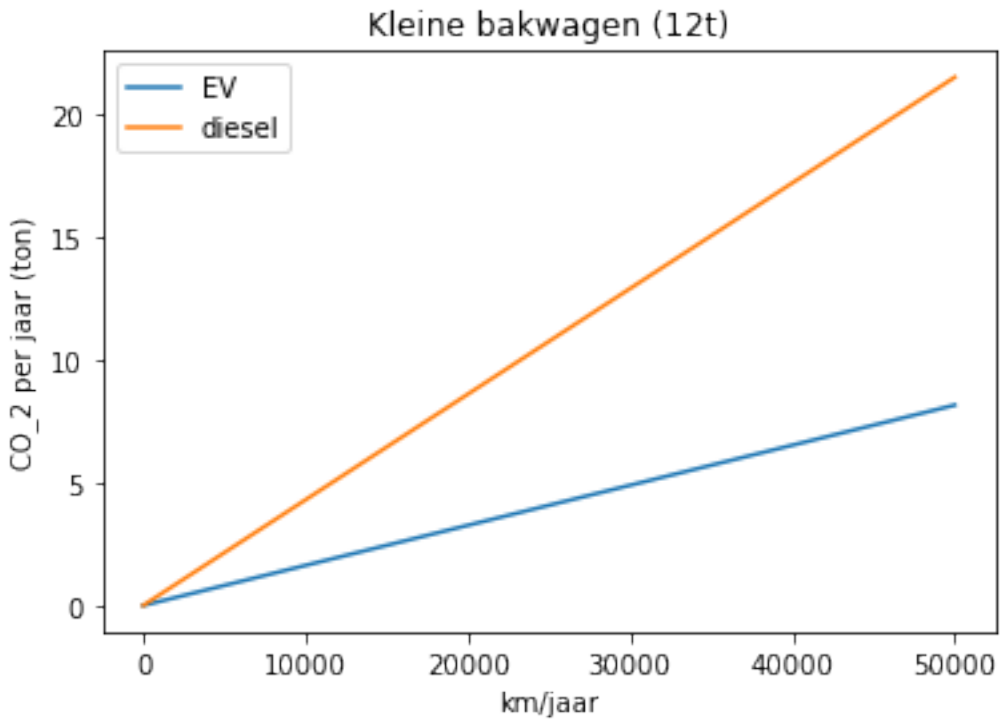
make a pie plot.



Calculate and plot the total costs per year vs the number of km/year.



Do the same for co2.



Show all the results in a table.

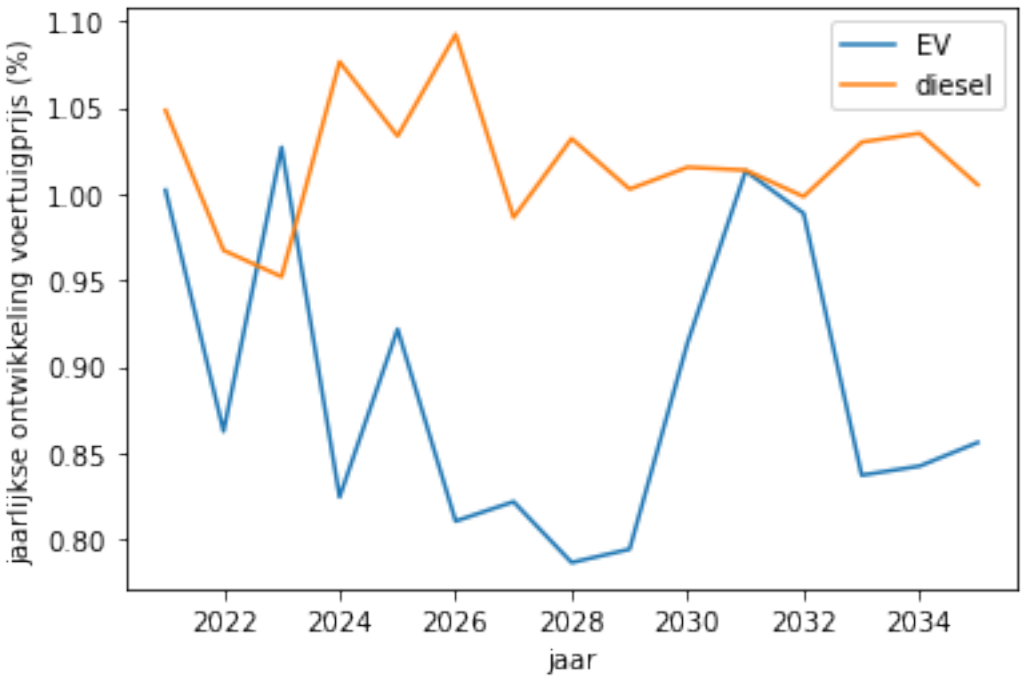
```
<IPython.core.display.HTML object>
```

1.0.3 Include a time axis to the model

To come up with a smart TCO model that includes the evaluation of the cost components in time, we need to define a time scale first.

```
[2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033,
2034, 2035]
```

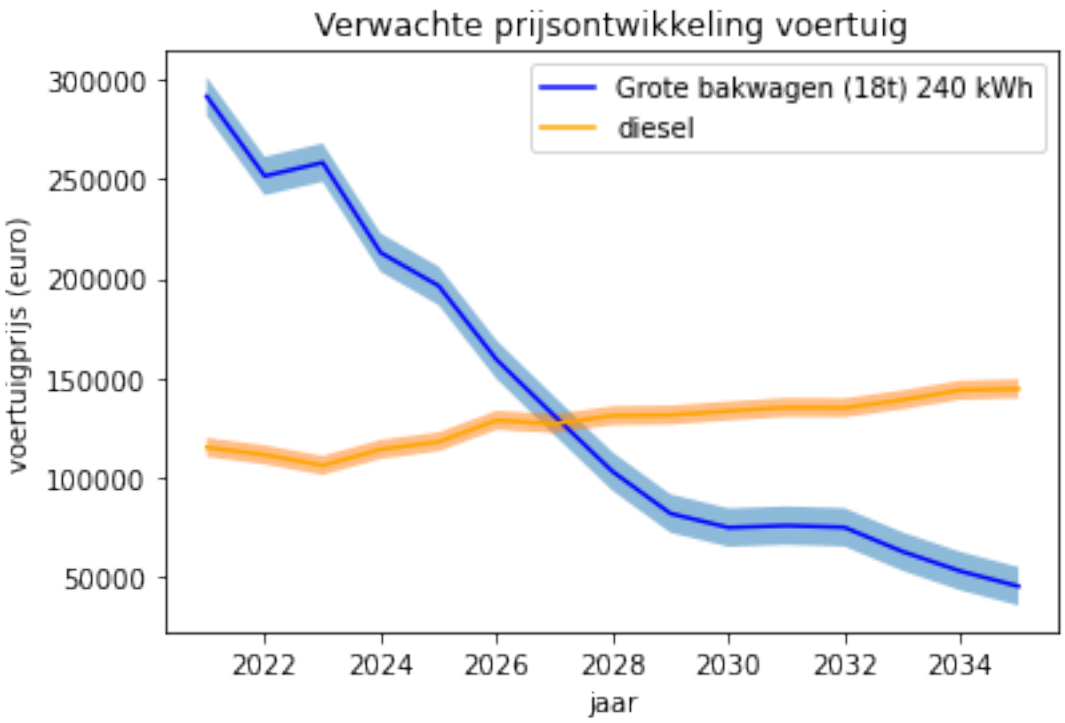
We predict a certain change in vehicle prices for both diesel and electric vehicles.



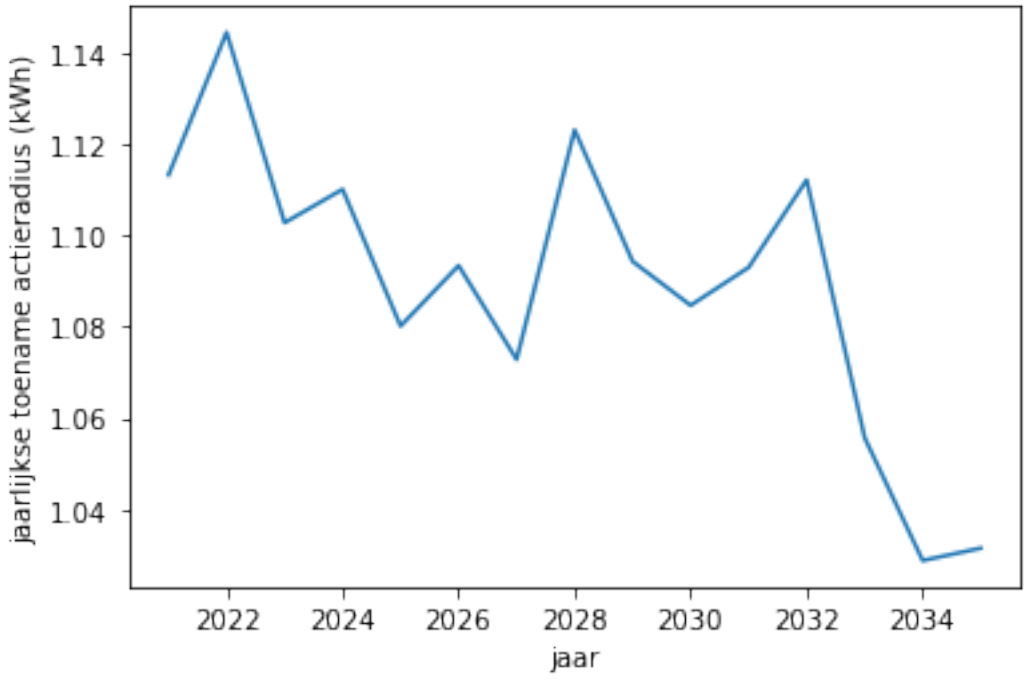
This is multiplied by the current vehicle prices that can be read from the excel sheet 'Model parameters'.

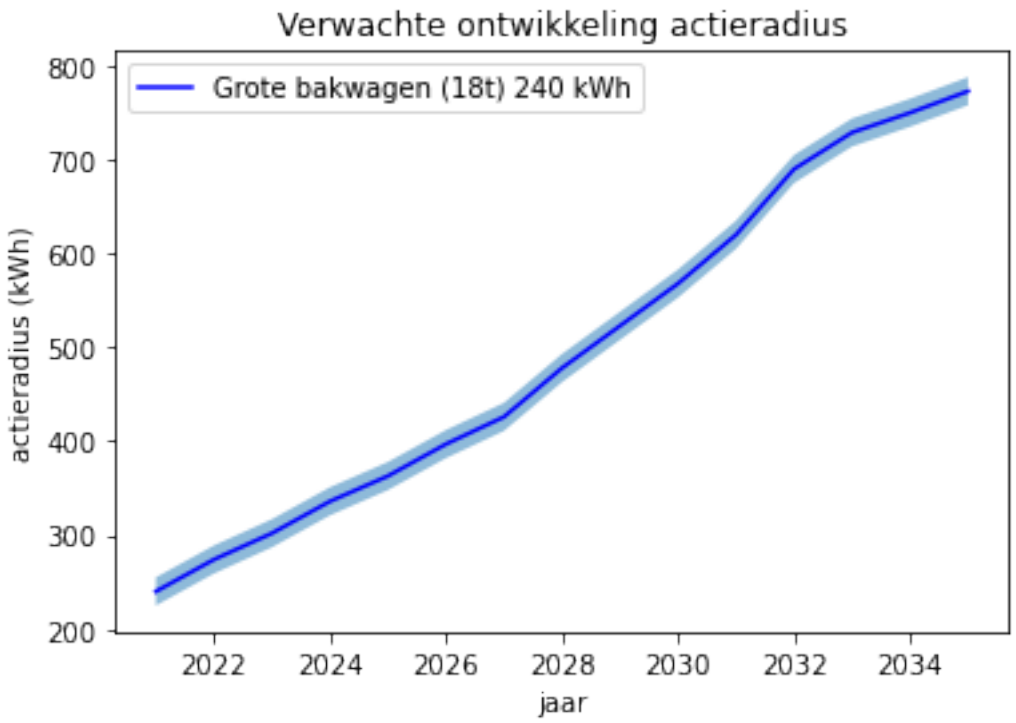
The mean and standard deviation can be drawn from the data.

We can plot the price evolution for a certain type of vehicle, with a band denoting the standard deviation.



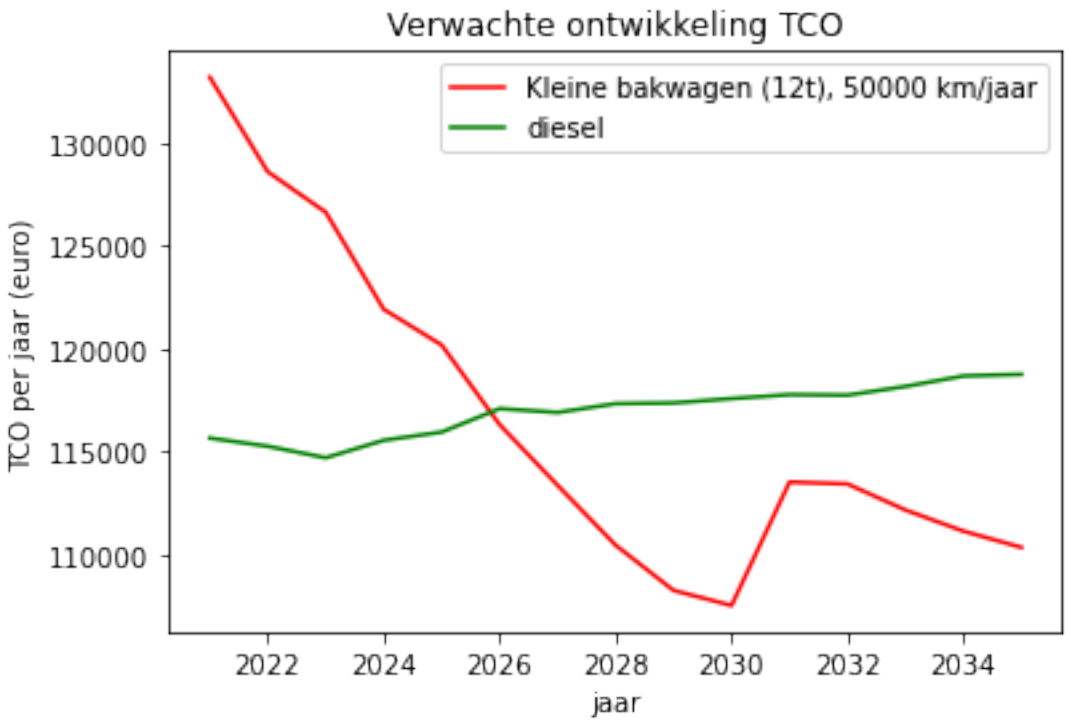
Predict the evolution of the action radius in time, which we assume is growing logarithmicly:





Now we are able to change the input parameters in the excel sheet over the years, and read how the tco values for a certain type of vehicle will evolve accordingly.

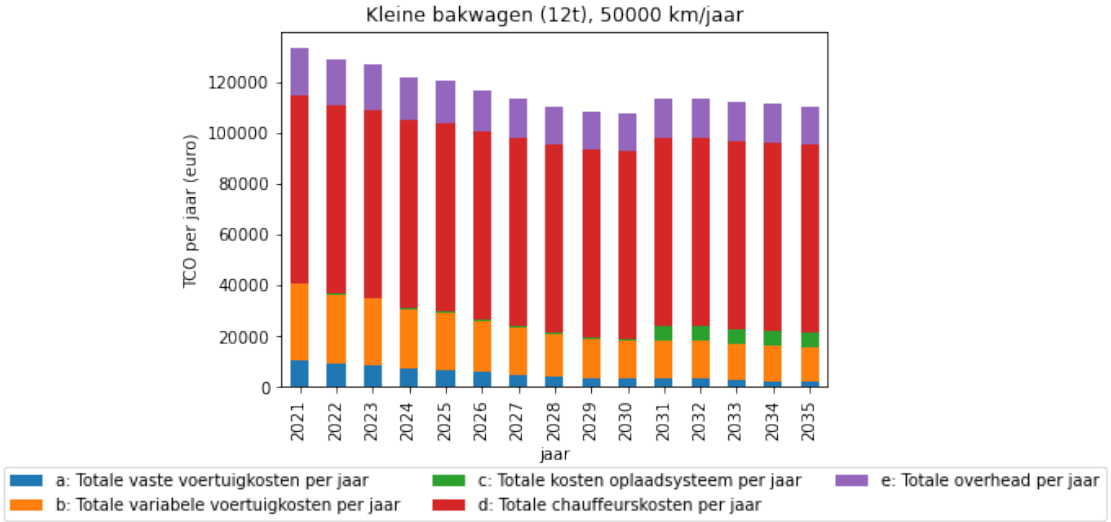
Again, we can plot the curves for this type of electric and diesel truck.



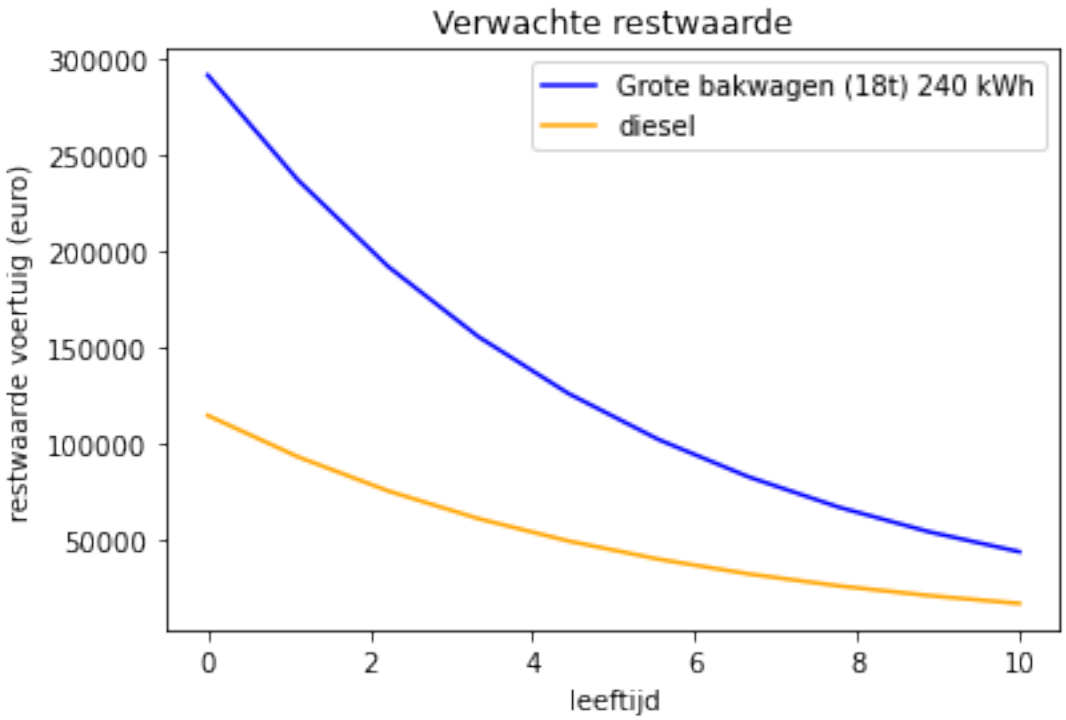
Obtain the year of intersection, where 'tco diesel' = 'tco electric'

`year that "TCO EV" = "TCO diesel" =  5`

Put the results in a histogram.



Predict the evolution of the residual value in time



1.0.4 Find best time to replace diesel vehicle by BEV

There are several strategies that can be followed by a company. We defined three strategies, but the user can also come up with their own stategy. - strategy 1: replace diesel vehicle with similar electric vehicle if old vehicle is written off - strategy 2: keep diesel vehicle x years longer, or until tco diesel = tco electric (with max(x) = 5) - strategy 3: replace old diesel truck with new diesel/hybrid truck truck until year y, where y is the year that tco diesel = tco electric - strategy 4: replace diesel vehicle as soon as tco_diesel = tco electric

For each strategy we calculate the year of transition to EV's for a certain strategy and economic scenario.

As opposed to the technical life span of a vehicle, the economic life span also takes into account the operational costs compared with alternative vehicles. For example, once electrical vehicles become much cheaper than diesel in operational costs, your diesel truck might be written off after 5 instead of 7 years to avoid having higher costs than your competitors.

N.B. Ik gebruik waarden in het jaar dat wordt aangekocht voor de eerste 7 jaar. Dus de vaste kosten (=voertuigprijs) gaan niet omlaag, maar de waarde van electriciteit en diesel doen dat wel en de restwaarde veranderd ook. De kosten van het oplaadsysteem zijn ook afhankelijk van jaar van aankoop. Ik neem ook mee dat de restwaarde van diesel sterk zal dalen vanaf jaar 'intersect' en dat dit dus de vaste kosten over alle jaren daarvoor zal beinvloeden. De restwaarde van electrisch stijgt juist, verder zullen subsidies alleen de komende paar jaar worden uitgegeven naar alle waarschijnlijkheid.

Here we read the life span of diesel and electric vehicles and the years one would normally replace

the diesel vehicle.

```
Life span diesel: 7

Life span electric: 7

Replace vehicle in: 2024 and 2031
```

For strategy 2 we can calculate the extra years that an old vehicle is kept onto, with a maximum of x years.

```
extra years:  2
```

Based on the year that the tco value of diesel and EV intersect for a certain type of vehicle, the strategy that is prefered, and the current age of the vehicle we can calculate the year that the vehicle is replaced and when to buy electric instead of diesel.

read the yearly costs for diesel vehicles from the sheet:

read the yearly costs for electric vehicles from the sheet.

For each vehicle calculate the average costs during the vehicle life span and update the costs each year (variable costs: electricity/diesel price, maintenance costs, fine on emissions or extra costs made in ZE zones) or in the year of replacement (fixed costs: price, residual value, purchase subsidies, purchase of new loading pole).

This function calls the function that calculate the tco (components) and co2 emissions for a certain type of vehicle with a certain age and for a certain strategy. It also checks the validity of the input parameters.

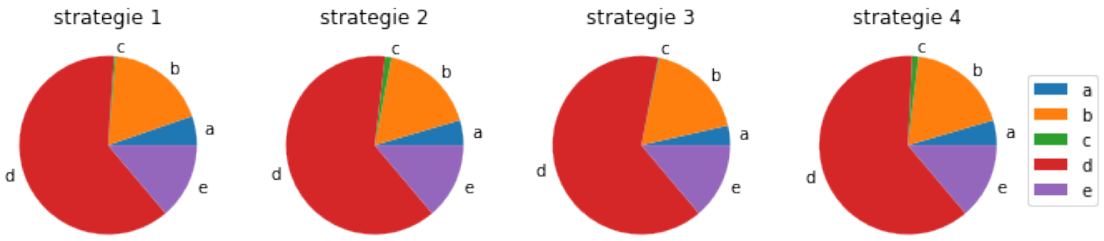
For a vehicle with a certain age call all four strategies and return the costs/emissions.

calculate result for 4 different strategies with age = 5 and x = 3

put in table format.

```
<IPython.core.display.HTML object>
```

Plot in pie chart for the last vehicle that was calculated:



1.0.5 Calculate and plot the TCO and CO2 emissions for a fleet of vehicles

We can calculate for a company the best 'transition strategy' for each vehicle they own and what the total emissions are for their entire fleet. Moreover, loading costs might be cheaper when vehicles can share a loading pole (N.B. Voeg dit toe).

Insert the details for a vehicle in the sheet.

List all vehicles of a company and put in a table.

```
Aantal voertuigen: 6
```

```
<IPython.core.display.HTML object>
```

Calculate the results.

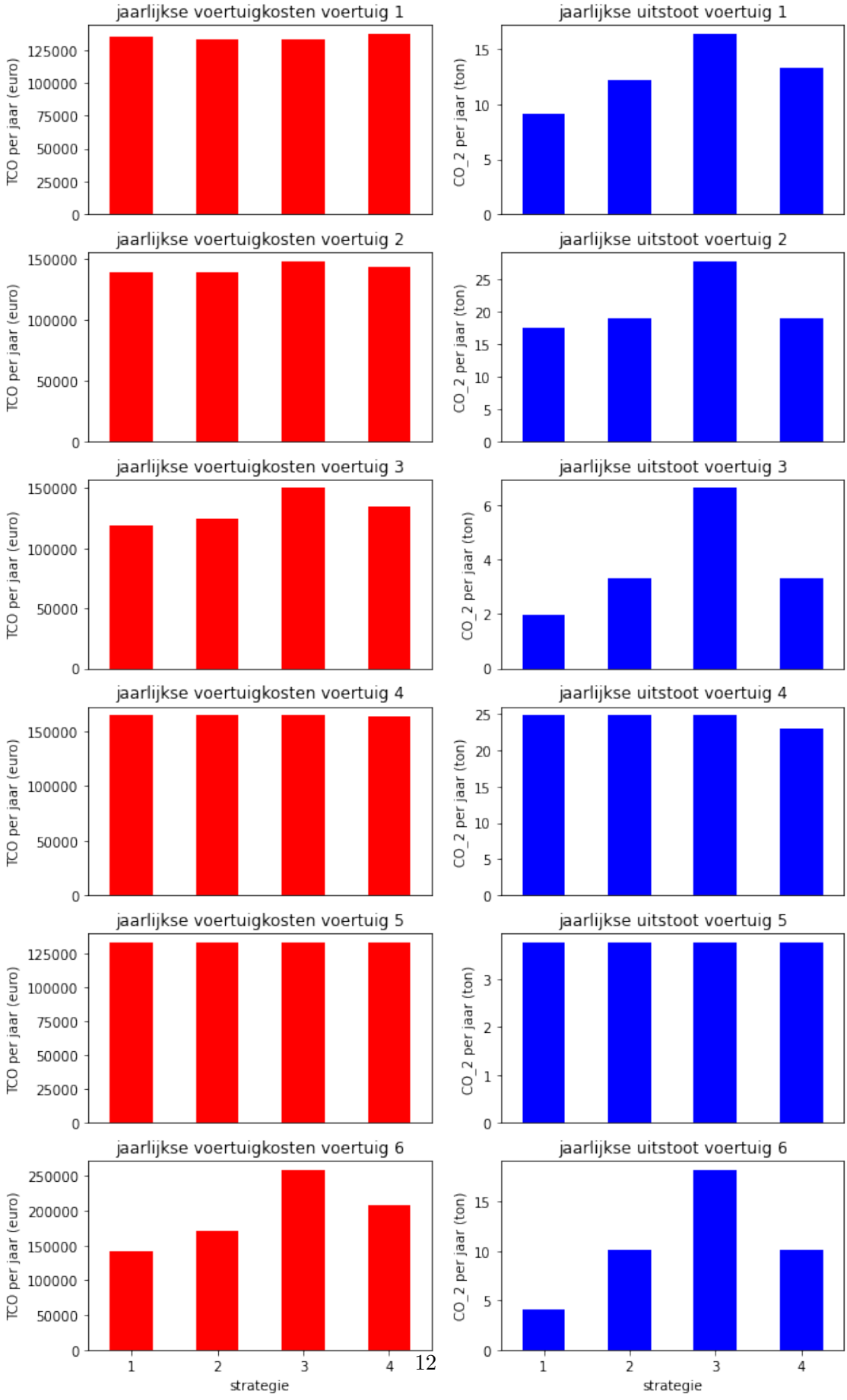
Put the total tco costs in a data frame.

Put the total co2 emission in a data frame.

Put the results in table format

```
<IPython.core.display.HTML object>
```

Plot the average yearly tco costs until 2035 (or a different number of years) for each strategy in a bar plot. Also show how the emissions per strategy differ for wach strategy. N.B. Also draw a line with the expected savings on co2 emissions.


jaarlijkse voertuigkosten voertuig 1
TCO per jaar (euro)
jaarlijkse uitstoot voertuig 1
CO_2 per jaar (ton)
jaarlijkse voertuigkosten voertuig 2
TCO per jaar (euro)
jaarlijkse uitstoot voertuig 2
CO_2 per jaar (ton)
jaarlijkse voertuigkosten voertuig 3
TCO per jaar (euro)
jaarlijkse uitstoot voertuig 3
CO_2 per jaar (ton)
jaarlijkse voertuigkosten voertuig 4
TCO per jaar (euro)
jaarlijkse uitstoot voertuig 4
CO_2 per jaar (ton)
jaarlijkse voertuigkosten voertuig 5
TCO per jaar (euro)
jaarlijkse uitstoot voertuig 5
CO_2 per jaar (ton)
jaarlijkse voertuigkosten voertuig 6
TCO per jaar (euro)
jaarlijkse uitstoot voertuig 6
CO_2 per jaar (ton)
1
2
3
4
strategie
1
2
3
4
strategie

1.0.6 Calculate loading capacity

1.0.7 Close Excel workbook